



# Phosphorus Wastewater Treatment

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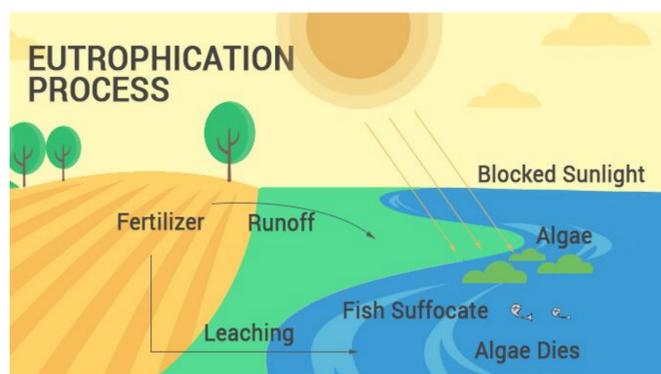
## Background

Excessive phosphorus in wastewater causes damage to aquatic environments due to eutrophication<sup>[1]</sup>:

- ▶ Increased nutrients leads to high growth of plant life (usually algae)
- ▶ Bacteria depletes oxygen while decomposing algae, creating a hypoxic zone
- ▶ Plant and animal life trapped in the hypoxic zone are at risk of harm or death, and the ecosystem is destabilized

Eutrophication is a major environmental issue around the world, and in Southern California:

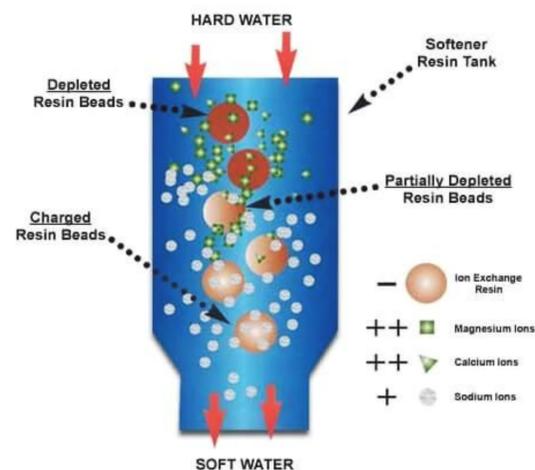
- ▶ Most of the contiguous US coast is “moderately to severely” affected<sup>[2]</sup>
- ▶ 12 out of 15 analyzed sites in Southern California had “moderate” or “worse” eutrophic condition<sup>[3]</sup>



**Figure 1:** The process of **Eutrophication**. Runoff **phosphorus** depletes aquatic oxygen and results in hypoxic zones.

## Current Design

Ion-Transfer Columns



**Figure 2:** A diagram of the ion-transfer process, illustrated with hard water

**Ion Transfer:** Resins filter out phosphates via electrostatic attraction.

**Regeneration:** After phosphate saturation, regenerating agents are added to the column to extract phosphate group from the beads.



**Figure 3:** Wet and dry precipitate



**Figure 4:** Packed ion exchange column

## Protocols

Continuous flow methods are used to determine the effectiveness of the beads in a flow system. The conditions currently being tested are residence time, surface area, and resin regeneration. Further experiments can be conducted with columns to resemble a water treatment system. The optimal conditions to be determined include flow rate and phosphorus concentration.

## Path Forward

- ▶ The next objective is to scale up our continuous flow system and optimize experimental parameters, e.g. flow rate, column length, etc.
- ▶ Our long-term goal is to implement our ion-exchange column methodology to wastewater.
- ▶ We plan to utilize the collected phosphate as fertilizer for UCSD community gardens.

### Sources:

[1] US Department of Commerce, & National Oceanic and Atmospheric Administration. (2017, October 5). What is eutrophication? Retrieved from <https://oceanservice.noaa.gov/facts/eutrophication.html>  
 [2] US Department of Commerce, & National Oceanic and Atmospheric Administration. (2017, October 5). What is eutrophication? Retrieved from <https://oceanservice.noaa.gov/facts/eutrophication.html>  
 [3] McLaughlin, K., Sutula, M., Busse, L., Anderson, S., Crooks, J., Dagit, R., ... & Stratton, L. (2014). A regional survey of the extent and magnitude of eutrophication in Mediterranean estuaries of Southern California, USA. *Estuaries and coasts*, 37(2), 259-278.  
 World phosphorous use crosses critical threshold. (n.d.). Retrieved from <https://www.constantinealexander.net/2011/02/world-phosphorous-use-crosses-critical-threshold.html>

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